ATTACHMENT 1
INVASIVE SPECIES CONTROL METHODS FOR
DESIGN, CONSTRUCTION AND OPERATIONS

(This attachment is considered to be a “living document” and will be updated and revised, as appropriate, to incorporate innovations and advances in the science of invasive species control.)

I. General Considerations

1. Identification- Learn to identity the priority invasive plant species in your area. Throughout NYS, four priority species are Purple loosestrife, Common reed (Phragmites), Japanese knotweed and Giant hogweed. Additional invasive species may be of priority concern in your area (see http://www.ipcnys.org on PRISMs priority species). Once you know which invasive species are priorities in your area, learn how to identify these plants, animals and pathogens. Located under the Water Ecology Section of the Environmental Science Bureau IntraDOT Website, the Invasive Species Webpage provides links to help identify many invasive species.

2. Inventory- Developing an inventory of the priority invasive plants in your area is important for several reasons. First and foremost, knowing where the invasive plants live is essential to any future control efforts. Secondly, once their locations are known, they will continue to exist and spread until they are controlled. Thirdly, since invasive species can show-up at any time and are easiest to control when they first invade an area, it’s important to continually update the inventory. Inventory is discussed further in Attachment 5 of this chapter.

3. Early Detection and Rapid Response- Invasive species, by there nature, spread very rapidly once introduced to a new area. Therefore it is essential that new infestations be identified and controlled as quickly as possible. Control practices for small populations are far more likely to succeed, are significantly less expensive and provide more options for control methodology.

4. Minimize Soil Disturbance- Due to the nature of invasive plants to rapidly colonize areas of disturbed soil, out-compete native species and become firmly established very quickly, it is essential to minimize areas of soil disturbance.

5. Temporary Erosion and Sediment Control- Department policy requires sound temporary erosion and sediment control practices on all projects that disturb soil. This practice is particularly important in preventing the introduction and continued spread of invasive plant species. Where invasive species are known to exist, rapid and diligent erosion and sediment control, as per Section 209 of the Department Standard Specifications is particularly important.

Note: Some of the methods described below require actual digging or pulling of plants from the soil. In all cases they require removal of vegetation whether or not there is actual soil disturbance. Each situation must be studied to determine if the proposed
control method will destabilize soils to the point where erosion is threatened (or invasive plants may re-establish).

6. Mulch- Due to the nature of invasive plants to rapidly colonize any area of disturbed soil, it is essential that all disturbed areas be mulched and seeded as soon as possible. If outside the growing season for seed germination, disturbed sites should still be mulched. Sources of mulch should be free of invasive plant parts or seeds. Use of straw or wood fiber mulch is preferred. If hay mulch is used, it should be verified as originating from an invasive-free source. See NYSDOT Engineering Instruction EI 07-013- Reissue of Revision to Standard Specifications- 209 Erosion and Sediment Control, 610 Turf and Wildflower Establishment and 713 Landscape Development Materials, 9/06/07.

7. Rapid Revegetation- Although not a specific condition, replanting or reseeding with native species is highly desired. All of the control methods below are aimed at reducing or eliminating invasive species so that natives are encouraged to grow and re-establish stable conditions that are not conducive to invasive colonization. In most cases removal or reduction of invasive populations will be enough to release native species and re-establish their dominance on a site. Replanting may be desirable on private lands where it can be used as a quid pro quo with the landowner for permission to remove invasive plants.

8. Planting Considerations- When specifying plantings in Landscape Design, consider plants (in preferred order) that are: native; non-native, non-invasive that are locally grown; or non-native, non-invasive that are regionally grown. Natives are preferred but there are many exotic non-invasive species available (only about 5% of exotic species are considered invasive). Choosing locally grown stock reduces the chances of introducing non-native genotypes (variety) of native species. Additionally, choosing plants that are regionally grown minimizes the risk of introducing invasive pests and pathogens to the site from across the nation (and the world).

II. General Control Concepts by Activity Type

1. Mowing- Don’t be “Johnny Phragmites Seed”! Maintenance roadside mowing, while essential for safety, operational, aesthetic and environmental purposes, can, has and does play a significant role in the introduction, spread and proliferation of invasive plants. If considered as a control practice, due to the tremendous reproduction and rapid growth rates of invasive plants, repeated and time-specific mowing will be required. Considering that mechanical mowing spreads invasive plant seeds and that each segment of many invasive plants, including the rootstock, can vegetatively sprout a new plant, priority invasive plant species should be mowed with due consideration for the following factors:

Note: Since drainage ditches, streams and wetlands can rapidly spread invasive plants through dispersal of seeds and, to a lesser degree, plant parts, it is strongly recommended to control (herbicide, excavate, etc.) priority invasive plant populations in and adjacent to drainage ditches and streams, prior to mowing. This also will provide operational benefits because invasive plant populations in the drainage system that are “only” mowed will
immediately re-grow and spread and therefore require additional mowing. Isolated (upland) roadside populations of invasive plants can be mowed with less chance of dispersing the plant seeds and parts to new areas, however mowing should always be done prior to seed maturation— generally prior to **August 1st**.

Mowing Considerations:

a. When mowing untreated or uncontrolled invasive plant populations, do so prior to seed maturation (generally prior to August 1st for the first mowing of the year);

b. Plan on mowing invasive plant populations 2-3 times per year, prior to seed maturation, for successive years if mowing is the only control practice used. The “mowing only” option should be used in locations that are not in or adjacent to drainage ditches and are inaccessible or too large for other control options;

c. Control small invasive plant populations comprised of tender, young plants with herbicide early in the summer, prior to mowing, especially in and adjacent to drainage ditches;

d. If invasive plant populations consist of large, mature plants, mow the plants prior to seed maturation, allow the plants to re-grow to a height of 2-4 feet and then treat with foliar herbicide, especially in or adjacent to drainage ditches;

e. Physically remove flower or seed heads (cut and bag) of small invasive plant populations prior to mowing, especially in and adjacent to drainage ditches;

f. Physically remove rootstock (mechanically excavate) of small invasive plant populations prior to mowing, especially in and adjacent to drainage ditches;

g. Control large purple loosestrife plant populations with biocontrol beetles (Hylobius sp. or Galerucella sp.) prior to mowing. Beetle releases will take several years to significantly reduce purple loosestrife populations;

h. If mowing occurs after seed maturation, hand clean, with brush or broom, upper parts of contaminated mowing equipment prior to moving to new locations, especially uncontaminated locations. This is especially important for purple loosestrife as each mature plant is capable of producing up to **2.5 million** viable seeds;

i. Take care to minimize scalping and rutting during mowing operations. These situations can be avoided by properly adjusting the equipment and avoiding operating equipment directly in wet areas or rough terrain. Any scalped or rutted areas should be immediately seeded and mulched. Any badly rutted areas should be repaired, seeded and mulched; and

j. Use of optional mowing equipment, such as “over-the-rail” boom-type mowers may be necessary in some situations to reach invasive plants;

2. **Herbicides** - Judicious use of herbicides is an important tool in invasive plant control efforts. All herbicide use shall be in accordance with label instructions, state and federal law (including adjacent landowner notification) requirements and will be conducted by, or under the supervision of certified applicators. Herbicide application techniques will generally fall under two types: 1. foliar application; and 2. stem injection or cut-and-treat. As a general rule, foliar herbicides should be applied to actively growing plants prior to flowering. A common practice is to mow or cut an invasive plant infestation, prior to seed maturation, allow the plants to re-grow to a height of 2-4 feet and then apply the appropriate foliar herbicide. This process will weaken the plant and prevent spread by...
Stem injection involves using a syringe or similar injection system (eg: JK injection systems and others) to introduce a pre-measured concentrated dose of herbicide without the need of cutting prior to treatment. This method works well for treating Japanese knotweed. If manageable stands of invasive plants extend beyond the R.O.W., consider obtaining a written release from the adjacent landowner to implement controls. All sites where herbicides are applied should be inspected 3-4 weeks post application to assess success and to determine if natural re-vegetation by native or non-invasive plants is adequate or if additional restoration, e.g. seeding and mulching, is required. A list of approved herbicides for invasive species control is available on Attachment X. If herbicides are used in a NYSDEC Freshwater Wetland, including the 100ft (30m) Adjacent Area, a NYSDEC Article 24 permit is required. If herbicides are applied over open water, a NYSDEC Article 15 permit is required. Information can be found under Aquatic Pesticides on the NYSDEC website at: [http://www.dec.ny.gov/chemical/8530.html](http://www.dec.ny.gov/chemical/8530.html)

3. **Biological Controls-** On large, dense stands of purple loosestrife (1/2 acre or larger), use of *Hylobius transversovittatus* and *Nanophyes marmoratus* weevils; *Galerucella calmariensis* and *G. pusilla* beetles are very effective control options. Cornell University conducted extensive research prior to the selection of this particular species and prepared a Generic Environmental Impact Statement for their release throughout New York State. These beetles feed exclusively on purple loosestrife (they will starve rather than eat any other plants), will reproduce after release and can be harvested from prior release sites for use in other locations. NYSDOT has a hylobius “donor” site in Region 2 at the Utica Marsh complex; Region 3 is currently developing beetle nurseries. For additional information regarding biological controls, see: [http://www.nysa.es.cornell.edu/ent/biocontrol](http://www.nysa.es.cornell.edu/ent/biocontrol).

Research is currently well underway by Cornell University to identify and test an effective biological control(s) for Phragmites (see Attachment 7). Unfortunately, no acceptable biocontrols currently exist for Japanese knotweed.
4. **Ditching**- Any priority invasive plants prefer moist soil conditions and are tolerant of saline environments, therefore grow very well in highway drainage ditches and other components of the drainage system. As the dense root systems of invasive plants such as purple loosestrife, phragmites and Japanese knotweed proliferate, they rapidly clog drainage ditches and reduce sight distances, especially where water velocities slow, e.g. up gradient of culvert inverts, above check dams, etc. Due to the rapid growth of invasive plants, maintenance cycles are far more frequent where they exist. Prior to excavating the plants from drainage ditches, the entire invasive plant infestation should be treated with the appropriate herbicide formulations. Applications near surface water require aquatic-use registered herbicide (eg: Rodeo, Aquamaster, etc.) This will ensure that the plants, seeds and root parts will not spread and re-establish. Failure to treat the invasive plants prior to physical removal will most likely result in immediate re-growth of the plants in the ditch and the spread of the plant to adjacent and downstream areas. In addition, if the invasive plants are not killed prior to ditch cleaning, the spoil produced can further spread the plants upon disposal (see No. 8. below); 

5. **Shoulder Scraping**- Removing the build-up of organic material along highway shoulders is essential to maintaining pavement quality, providing adequate sheet flow drainage and providing safe driving conditions. Due to their disturbed nature and harsh growing conditions, highway shoulders provide a prime area for invasive plants to establish and spread. This is due to the nature of invasive plants to rapidly colonize disturbed areas and to tolerate harsh environmental conditions. Therefore it is essential that shoulder scraping activities address invasive plant control. Prior to scraping highway shoulders, all existing priority invasive plants should be treated with appropriate herbicide or other control measure to kill seeds and plant parts, including the root stock. This will prevent the plant from reseeding, re-sprouting in-situ or spreading to adjacent areas via, water, wind, hitching a ride on equipment or through spoil disposal (See No. 9 below); 

6. **Vine, Brush and Tree Removal**- Several common species of vines, brush and trees that grow profusely along highway roadsides are considered invasive species. These species frequently cause a nuisance to maintenance workers, block traffic signs or limit sight distances and therefore are removed in routine maintenance operations. In the evaluation of these removal priorities, invasive species should be given preference and controlled by accepted practices that will ensure no re-sprouting and prevent additional spread through seed dispersal. Since most brush, vine or tree species do not reproduce vegetatively (from above-ground plant fragments), such plant parts do not need to be disposed of, unless berries/seeds are present on branches during removal. Accepted methods of control include foliar herbicide treatment or cutting followed by stump treatment with herbicide. Mowing or cutting alone frequently results in re-sprouting and cloning, and is not an effective control methodology. 

Tree crews removing dead/ dying trees should learn how to identify invasive insect species, such as Emerald ash borer (EAB), Asian long-horned beetle (ALB) and Sirex wood wasp, as well as damage caused by such species. For more information, see USDA Animal and Plant Health Inspection Service (APHIS) website: [http://www.aphis.usda.gov/plant_health/plant_pest_info/index.shtml](http://www.aphis.usda.gov/plant_health/plant_pest_info/index.shtml)
and U.S. Forest Service website: 
http://www.na.fs.fed.us/fhp/index.shtm

7. Poisonous Plant Removal- A few invasive species pose serious threat to worker safety and public health. Giant hogweed, *Heracleum mantegazzianum*, is such a plant. Upon dermal contact this plant causes severe skin burns which are exacerbated through exposure to sunlight. Where ever this plant is encountered, the location should be located using GPS coordinates and reference marker identification, the size of the population noted and maintained in a regional database. When encountered, Giant hogweed populations should be controlled using appropriate BMPs. This plant’s distribution is being tracked by the NYS Department of Agriculture & Markets and NYSDOT can provide significant information to this statewide inventory effort. A similar invasive plant that is spreading throughout the state is Cow parsnip, *Heracleum lanatuin*. This plant is smaller than Giant hogweed and results in many of the same symptoms although to a far less severe degree. We’ll have to keep an eye on Cow parsnip as it appears to be spreading along roadsides and may elevate to a status of statewide significance.

8. Bridge Washing- All bridge washing activities, whether for biannual maintenance or in preparation for re-painting, require the use of water. Several invasive plant and animal species are aquatic or are dispersed through water. Therefore, Department activities that require the transport and use of water need to consider invasive species control. Control considerations include use of municipal water sources, filters on water intakes, decontamination/sanitation of equipment and use of in-situ water sources. In addition, the equipment used in transporting and spraying water should be cleaned prior to use or between use at sites in different watersheds. See additional guidance in NYSDOT Engineering Instruction EI 07-032- Maintenance Cleaning and Washing of Bridges- US Customary, 9/12/07;

9. Disposal- Proper disposal of harvested invasive plant parts and soil containing invasive plant seeds or root stock (and rhizomes) is essential to control the spread of invasive plants. Full consideration should be given, as appropriate, as follows:

*Transportation* - While on the treatment site, bag all cut living plant material in heavy duty, 3 mil or thicker, black contractor quality plastic clean-up bags. Securely tie the bags and transport from the site in a truck with a topper or cap to securely fasten the load, in order to prevent spread of the plant material from the project work site. Transport the material to an appropriate disposal location;

*Compost* - Because of the extremely robust nature of invasive species, composting in a typical backyard compost pile or composting bin is not appropriate. However, methods can be used whereby sun-generated heat can be used to destroy the harvested plant materials (excluding seeds and seed heads). For instance, storage in a sealed 3 mil thickness (minimum) black plastic garbage bags on blacktop in the sun until the plant materials liquefy is effective. If a larger section of blacktop is available, make a black plastic (4 mil thickness minimum) envelope sealed on the edges with sand bags. The plant material left exposed to the sun will liquefy in the sealed envelope without danger of dispersal by wind. The bags or envelopes must be monitored to make sure the plants
do not escape through rips, tears or seams in the plastic;

Bury - Due to the incredible capacity of many invasive species to reproduce by seed, clone and vegetative propagation, it is absolutely imperative that spoil material contaminated with invasive plant material NOT be disposed-of in an indiscriminant manner. It is recognized that the Contractor owns spoil material and therefore, contract documents should identify locations of contaminated soil and address disposal options. Spoil material that contains invasive plant material should be buried with at least two meters (6 feet) of uncontaminated fill material;

Landfill/ Incinerator - If harvested invasive plant parts or spoil material containing invasive plant material is not composted or buried, it should be transported directly to a sanitary landfill operating under current 6 NYCRR Part 360 regulations for proper disposal;

NYSDEC Quarry/ Mine Reclamation - Material may be transported to an approved quarry/ mine site that is accepting infested material. Regions, such as Region 7, have found potential sites and are inputting information on GIS for future consideration;

Approved NYSDOT disposal facilities - Surplus properties may offer opportunity for use as disposal facilities, maintained by Regional Operations Groups.

To the maximum extent possible, dispose of infested material on-site when site conditions are favorable for such disposal. For projects that do not include eradication efforts (eg: site locations found within large contiguous infestations), but produce infested surplus soil, consider disposal in infested upland areas within the ROW, when practicable. While this option does not eliminate the infestation, it minimizes potential spread off-site, as well as minimize off-site disposal cost. Stabilize soil using E&SC practices, such as seed and mulch.

10. Equipment in Water Bodies - Several invasive species are aquatic and many additional non-aquatic species are readily spread by the movement of flowing water. Many aquatic invasive species are capable of survival out of water for extended periods. To prevent the accidental introduction of invasive species that are “hitching a ride” on construction equipment, all equipment that is to be placed in a water body should be cleaned, as appropriate, e.g.: tracks, buckets, to remove invasive species and their seeds and propagules. This requirement applies to equipment arriving on the project and equipment that is being relocated within the project;

11. Cleaning of Equipment - Cleaning should occur prior to equipment arriving on-site. Once on-site, if equipment involved in earthwork is contaminated with invasive species, the equipment should be cleaned prior to moving into uncontaminated areas. Cleaning shall consist of using physical means and hand tools, such as brushes, brooms, rakes or shovels, on all track and bucket/blade components to adequately remove all visible dirt and plant debris. If water is used, the water/slurry shall be contained and filtered so as to restrict introduction of invasive plants, seeds and propagules into the project or off-site through future surplus material disposal. Cleaning equipment near the infested area without a cleaning station is acceptable if space on project site is limited. For use of cleaning stations provided the material washed off equipment does not enter a
waterbody. For project sites, choose locations for equipment cleaning stations that will be buried in later stages, if possible. See Attachment X for *Vehicle Cleaning Technology for Controlling the Spread of Noxious Weeds and Invasive Species* guidance provided by the USDA Forest Service;

12. **Restricted Construction Equipment Access** - To prevent the accidental introduction of invasive plants during construction or maintenance activities, all tracked equipment involved in earthwork should be cleaned to remove plants, seeds and propagules that may be hitch-hiking, prior to arrival on-site. If tracked equipment is used in earth work on a portion of a project where invasive species are known to exist, this portion of the earthwork should be conducted last, or the equipment shall be cleaned prior to use on any portion of the site that is known to be free of invasive plants.

**III. Detailed Control Practices by Priority Plant Species (10/28/09)**
(Note that control efforts are not limited to species described below. See also Section IV and consult with local PRISM to identify any additional potential concerns.)

**PURPLE LOOSESTRIFE, *Lythrum salicaria***

**Plant Description**
Purple loosestrife is a wetland perennial native to Eurasia that forms large, monotypic stands throughout the temperate regions of the U.S. and Canada. It has a vigorous rootstock that serves as a storage organ, providing resources for growth in spring and re-growth if the plant has been damaged from cuttings. New stems emerge from the perennial roots enabling the plant to establish dense stands within a few years. Seedling densities can approach 10,000-20,000 plants/m² with growth rates exceeding 1 cm/day. A single, mature plant can produce more than 2.5 million seeds annually which can remain viable after 20 months of submergence in water. In addition, plant fragments produced by animals and mechanical clipping can contribute to the spread of purple loosestrife through rivers and lakes.

**Management Options**
1. **Digging/pulling**
Effectiveness: Can be effective in small stands, eg: less than 100 plants, spotty to light density (up to 75% area), and less than 1/2 acre, especially on younger plants.  
Methods: Hand-pull plants less than 2 years old. Use of hand-held mini-tiller for plants greater than 2 years old gets most of roots w/ minimum soil disturbance. The mini-tiller has 3 heavy duty prongs on 1 side that are pushed under base of plant. Use leverage on handle to pry up plant out of ground. Use weed wrench for plants greater than 2 years old. Tool provides effective plant removal with minimal soil disturbance. In mucky conditions, put base of wrench on small piece of wood (eg: piece of 2"x4") to keep wrench from sinking into mud. Use shovel for plants greater than 2 years old. Dig up plant then replace soil and any existing cover.  
Cautions: Activity may increase habitat disturbance and increase spread of loosestrife. Follow-up treatments of sites may require up to 3 years (or longer) to eliminate re-sprouting from fragments left behind, and well as exhaust seed bank. Must pull/dig ENTIRE rootstock or re-sprouting will occur. Must pull/dig before the plants begun setting seed or must remove flower/seed heads first (cut into bags) to prevent spread of seeds. Also remove previous year’s
dry seed heads. Erosion control may be necessary. Disposal: Bag all plant parts and remove from site (compost at Regional DOT Residency with approval, dispose of in approved landfill or incinerate with appropriate permits).

2. Cutting
Effectiveness: Can be effective in small stands, eg: less than 100 plants, spotty-light density (1-75% area), and/or less than 3 acres, especially on younger plants.
Methods: Remove flower heads before they go to seed, so seed isn’t spread when cutting or mowing. Must repeatedly cut and mulch to permit growth of grasses.
Cautions: Need to repeat for several years to minimize spread of plants (method will not eliminate the infestation). Cutting does not affect rootstock, thus plant will re-grow. Cut pieces can be spread that will re-sprout. Once severed, stems are buoyant and may disperse to other areas and re-sprout.
Disposal: Bag all plant parts and remove from site (compost at Regional DOT Residency, dispose of in approved landfill or incinerate with appropriate permits).

3. Herbicide
Effectiveness: Use when greater than 100 plants but less than 3 acres in size (consider use of biocontrol release if area is greater than ½ acre).
Methods: Use glyphosate formulations only. If possible spray seedlings before they reach 12” in height. Apply prior to or when in flower (late July/Aug) so plants are actively growing. For spot application use a sponge-tip applicator w/wick.
Cautions: Be careful to avoid non-target plant species. Apply formulations approved for use in aquatic sites if loosestrife is growing in standing water or if spray will contact water.

4. Biocontrol
Several species have been shown to be effective in controlling purple loosestrife. Between 1992 and 2006, approximately 1 million leaf-eating and stem-feeding beetles (Galerucella calmariensis and G. pusilla), 100,000 root-feeding weevils (Hylobius transversovittatus) and 25,000 flower-feeding weevils (Nanophyes marmoratus) were released throughout New York State. The scientific literature indicates that the beetles are very specific to Purple loosestrife with only minor “spillover” effects that do not compromise non-target plant populations.
Effectiveness: Use if site has at least a half acre of light-dense stands.
Methods: The number of beetles released per site should be based on the size of the site, the density of loosestrife and the economics of purchase. More beetles are generally better than fewer.
Cautions: Use only if mowing, pesticide and herbicide use are not active practices on the site. The site should be sunny. Observations over the years have indicated that biocontrol is not significantly effected by permanently flooded conditions. Use only if winged loosestrife, (Lythrum alatum) and waterwillow (Decodon verticullatus) are not major components of the plant community on the release site. A NYSDEC permit (including annual monitoring) is required for biocontrol release. Purple loosestrife biocontrol monitoring protocol and application are available at: http://www.invasiveplants.net/monitoring/pl_Protocol.asp
COMMON REED (PHRAGMITES), *Phragmites australis*

**Plant Description:**
Common Reed, or Phragmites, is a perennial grass that can grow to 14 feet in height. Flowering and seed set occur between July and September, resulting in a large feathery inflorescence, purple-hued turning to tan. Phragmites is capable of vigorous vegetative reproduction and often forms dense, hyper-dominated stands. It is unclear what proportion of the many seeds that Phragmites produces are viable.

Note: In addition to the non-native invasive phragmites, a native variety, *Phragmites australis var. berlandieri*, also occurs in New York State although it is far less common than non-native phragmites, especially inland. In general, native phragmites has a lower stem density and has reddish-purple basal-stem coloration in the spring and summer. In fall, the native stem bases fade to chestnut brown and continue to fade to lighter brown-gray during winter. Non-native phragmites stem bases are uniform tan in color. Stems of native phragmites are smooth and shiny, as if polished, particularly in the winter, while the stems of non-native phragmites are dull, rough and ribbed. Specific identification guidelines available through Cornell University may be found at: [http://www.invasiveplants.net/phragmites/morphology.htm](http://www.invasiveplants.net/phragmites/morphology.htm). Information on assistance with diagnostic services is available at: [http://www.invasiveplants.net/diag/diagnostic.asp](http://www.invasiveplants.net/diag/diagnostic.asp)

**Management Options**

1. **Cutting and Pulling**
   **Effectiveness:** Both methods need to be repeated annually for several years to reduce spread of plants. Hand-pulling is an effective technique for controlling phragmites, but limited to small areas (less than ¼ ac.) with sandy soils. Pulling is not otherwise a recommended method for control.
   **Methods:** Cut and remove seed heads from control area during dormancy. Remaining dormant stems may be cut or mowed. During growing season, the best time to cut phragmites is when most of food reserves are in the aerial portion of the plant (when close to tassel stage, eg: at end of July/early August to decrease plant’s vigor. Some patches may be too large to cut by hand, but repeated cutting of the perimeter of a stand can prevent vegetative expansion. Phragmites stems should be cut below the lowest leaf, leaving a 6” or shorter stump. If integrating cutting with herbicide treatment, cut stems as close as possible to the ground, allowing for easier navigation when applying herbicides later in season. Hand-held cutters (eg: sythe) and gas-powered hedge trimmers work well. Weed whackers with a circular blade were found to be particularly efficient, though dangerous. Cautions: As with most grasses, cutting Phragmites too early in the growing season stimulates growth, increasing stand density. Conversely, waiting too long after tassel stage increases the risk for seed development and dispersal when removing stems. Remove cut shoots to prevent sprouting and forming stolons.
   **Disposal:** Cut or pulled material should be removed from the site and composted or allowed to decay on the upland to prevent sprouting any formation of stolons. Do not attempt to compost rhizomes.

2. **Herbicide**
   **Effectiveness:** Herbicide use is, at minimum, a 2 year, 2 step process because the plants may
need “touch-up” application, especially in dense stands since subdominant plants are protected by thick canopy and may not receive adequate herbicide in the first application.

Methods: Apply foliar herbicide during or after tassel stage when nutrients going back to rhizome and will translocate herbicide into roots. Minimize breaking stems as much as possible to allow herbicide to translocate to rhizomes. After 2 to 3 weeks following application, cut or mow down the stalks to stimulate the emergence and growth of other plants previously suppressed. If the plants are too tall to spray, cut back in mid summer and apply herbicide when re-growth reaches 2 to 3 feet tall. Use spray bottle for individual foliar spot treatments. Choose formulation, such as Rodeo, for applications in standing water or along a shoreline.

3. Cutting/ Mulching

Effectiveness: Can be effective in small stands, eg: less than 100 plants, spotty-light density (1-75% area coverage) and less than 3 acres.

Methods: Cut and mulch dead stems in winter to remove them and promote germination of native species. Repeat in second year and then every 3-5 years. Can do after herbicides (late summer/fall application of Rodeo while leaves are still green).
Sanitation: Clean all clothing, boots and equipment to prevent spread of seed.

4. Pulling

Effectiveness: Can be effective in small plants ie. less than 100 plants. Very labor intensive. OK for small patches. Best results in sandy soils.

Methods: Hand-pull plants less than 2 years old. Use shovel for plants >2 years old-dig up plant, then replace soil and any existing cover.
Disposal: Bag all plant parts and remove from site (compost at Regional DOT Residency with approval, dispose of in approved landfill or incinerate with appropriate permits).
Sanitation: Clean all clothing, boots, & equipment to prevent spread of seed.

5. Excavation

Effectiveness: Can be effective for patches up to ½ acre. Cost and limited availability of spoil disposal sites are limiting factors.

Methods: Heavy equipment that is tracked or rubber-tired may be used. If original grade is maintained, excavate stand no less than 2 meters (6 feet) deep and fill pit with suitable uncontaminated fill. If proposed grade < original grade, excavate stand no less than 2 meters (6ft) deep below proposed grade. In cases where proposed grade > original grade, excavate, if needed, no less than 2 meters (6ft) below proposed grade elevation. Perimeter of excavation should extend out a minimum 5 meters beyond the leading edge of infestation. Follow-up treatments may include herbicide application.

Cautions: Monitoring every 4 weeks or so during the growing season (or the following year) must be conducted to verify control of infestation.
Disposal: Bag all plant parts and remove from site (compost at DOT Residency with approval, dispose of in approved landfill or incinerate with appropriate permits). If suitable for embankment, the material may be buried beneath a minimum 2 meters (6 feet) of uncontaminated material.
JAPANESE KNOTWEED, *Polygonum cuspidatum*

**Plant Description**
Japanese knotweed is an herbaceous perennial which forms dense clumps 1-3 meters (3-10 feet) high. Its broad leaves are somewhat triangular and pointed at the tip. Clusters of tiny greenish-white flowers are borne in leaf axils during August and September. The fruit is a small, brown triangular achene. Knotweed reproduces via seed and by vegetative growth through stout, aggressive rhizomes. It spreads rapidly to form dense thickets that can alter natural ecosystems. Japanese knotweed can tolerate a variety of adverse conditions including full shade, high temperatures, high salinity, and drought. It is found near water sources, in low-lying areas, waste places, and utility rights of way. During flood events, plant fragments from Japanese knotweed can establish new stands downstream, significantly threatening riparian areas.

**Management Options**

1. **Digging**
   Effectiveness: This method is appropriate for small juvenile populations.
   Methods: Remove the entire plant including all roots and runners using hand tools. Juvenile plants can be hand-pulled depending on soil conditions and root development.
   Cautions: Care must be taken not to spread rhizome or stem fragments. Any portions of the root system or the plant stem not removed will potentially re-sprout.
   Disposal: All plant parts, including mature fruit, should be bagged and disposed of in the trash to prevent re-establishment (stockpile at DOT Residency with approval, dispose of in approved landfill or incinerate with appropriate permits). If suitable for embankment, material may be buried beneath a minimum of 2 meters (6 feet) of uncontaminated material.
   Sanitation: Clean all clothing, boots, & equipment to prevent spread of seed.

2. **Cutting**
   Effectiveness: Repeated cutting may be effective in controlling Japanese knotweed. Manual control is labor intensive, but an option where populations are small and isolated or in environmentally sensitive areas that will be consistently maintained.
   Methods: Cut the knotweed close to the ground at least 3 times a year. Planting native species to compete with Japanese knotweed may offer some control.
   Cautions: This strategy must be carried out for several years to obtain successful control. Cutting alone will not eliminate the species, therefore continuous maintenance is required. Greater success is achieved by integrating mechanical with herbicidal control methods. Consider the potential of spreading Japanese knotweed when using mower or power trimmer near surface water.
   Disposal: Bag all plant parts and remove from site (stockpile at DOT Residency with approval, dispose of in an approved landfill or incinerate with appropriate permits).
   Sanitation: Clean all clothing, boots, & equipment to prevent spread of seed.

3. **Herbicide**
   Effectiveness: glyphosate or triclopyr treatments in late summer or early fall are much more effective in preventing re-growth of Japanese knotweed the following year. Imazapyr added to other herbicides in accordance with manufacturers' labels have shown to be effective.
   Methods: Use glyphosate, triclopyr or imazapyr formulations.
Strategy:
1) Cut/mow dormant stalks early in growing season.
2) Mid to Late June - Cut growing stalks.
3) Allow knotweed to re-grow for approximately 4 weeks.
4) Apply foliar herbicide of to knotweed. Knotweed should be 2-4 feet in height.

Although cutting knotweed is not required, it is recommended for three reasons: 1) removing dormant stalks allows more herbicide to contact actively growing knotweed, meaning less product wasted; 2) cutting growing knotweed pulls reserves from rhizomes as well as allow for easier movement through stand when applying herbicide; and 3) foliar application to stands greater than 3-4 feet increases risk of drift to non-target plants and reduced herbicide surface coverage on target plants. Applications after August 1st show best results. If applying herbicide earlier in the growing season, use a systemic herbicide (eg: triclopyr, imazapyr, etc.) for best results.

**STEM INJECTION/ CUT AND TREAT**
Cautions: Established stands of Japanese knotweed are difficult to eradicate even with repeated herbicide treatments. However, herbicide treatments will greatly weaken the plant and prevent it from dominating a site. Adequate control is usually not possible unless the entire stand of knotweed is treated (otherwise, it will re-invade via creeping rootstocks from untreated areas). Empirical evidence is that triclopyr and imazapyr are more effective than glyphosate in causing Japanese knotweed mortality.

4. Compost
Because of the extremely robust nature of invasive species, composting in a typical backyard compost pile or composting bin is not appropriate. However, methods can be used whereby sun-generated heat can be used to destroy the harvested plant materials. For instance, storage in a sealed 4 mil thickness (minimum) black plastic garbage bags on blacktop in the sun until the plant materials liquefy is effective. If a larger section of blacktop is available, make a black plastic (4 mil thickness minimum) envelope sealed on the edges with sand bags. The plant material left exposed to the sun will liquefy in the sealed envelope without danger of dispersal by wind. The bags or envelopes must be monitored to make sure the plants do not escape through rips, tears or seams in the plastic.

5. Excavation
Effectiveness: Can be effective for patches up to 1/2 acre. Cost and limited availability of spoil disposal sites are limiting factors.
Methods: Heavy equipment that is tracked or rubber-tired may be used. If original grade is maintained, excavate stand no less than 2 meters (6 feet) deep and fill pit with suitable uncontaminated fill. If proposed grade < original grade, excavate stand no less than 2 meters below proposed grade. In cases where proposed grade > original grade, excavate, if needed, no less than 2 meters below proposed grade elevation. Perimeter of excavation should extend out a minimum of 5 meters beyond the leading edge of infestation.

Cautions: Follow-ups later in the season or the following year must be conducted to verify that all the plants have been removed.
Disposal: Bag all plant parts and remove from site (compost at DOT Residency with approval, dispose of in approved landfill or incinerate with appropriate permits). If suitable for embankment, the material may buried a minimum 2 meters beneath uncontaminated material.

GIANT HOGWEED, *Heracleum mantegazzianum*

**Plant Description**
Giant hogweed is a biennial or perennial herb growing from a forked or branched taproot. Plants sprout in early spring from the roots or from seeds. The best time to identify Giant Hogweed is when it’s blooming in late summer. Numerous small white flowers in July, clustered into a flat-topped umbel up to 2 1/2 feet across. Stems are hollow, ridged, 2-4 inches in diameter, 8-14 feet tall with purple blotches and coarse hairs. The hairs are especially prominent that circle the stem at the base of the leaf stalks. Leaves are lobed, deeply incised and up to 5 feet across. Fruit (containing the seed) is dry, flattened. Oval, about 3/8 inch long and tan with brown lines. Giant Hogweed can be confused with the following 3 plants that also grow along roadsides: 1. Cow Parsnip, *Heracleum lanatum*; 2. Angelica, *Angelica atropurpurea*; and 3. Poison Hemlock, *Conium maculatum*. All 3 of these plants are much smaller and flower earlier, typically from May to June. Cow Parsnip is the most likely to be confused with giant hogweed, however in addition to being much smaller, only 5-8 feet tall, the stems are only 1-2 inches in diameter and lack purple blotches and leaves are only 2-2 1/2 inches in diameter. Angelica is also much smaller, seldom reaching 8 feet tall, has a smooth stem, round greenish-white flower clusters and 2 foot diameter compound leaves with dozens of small leaflets. Poison Hemlock is 4-9 feet tall with smooth stems with purple blotches. Leaves are very finely dissected and small white flowers are arranged in numerous flat-topped clusters on many branches. The following NYSDEC link differentiates hogweed from its look-alikes: [http://www.dec.ny.gov/animals/41009.html](http://www.dec.ny.gov/animals/41009.html)

**About Giant Hogweed**
Giant hogweed is a member of the carrot or parsley family. It is native to the Caucasus region of Eurasia and was introduced to North America in the early 1900’s. It’s massive size and imposing appearance made it desirable for arboretums and gardens, however it soon escaped from cultivation and became established in rich moist soils along roadside ditches, stream banks, waste ground, along tree lines and open wooded areas. In New York State, giant hogweed escaped from cultivation near Rochester and has spread from this point, primarily east and west along the Thruway corridor.

**Health and Safety Concerns**
This robust plant is a worker and public health hazard because of its potential to cause sever skin irritation in susceptible people. Plant sap produces painful, burning blisters with 24-48 hours after contact. Plant juices can also produce painless red blotches that later develop into purplish or brownish scars that may persist for several years. For an adverse reaction to occur, the skin, contaminated with plant juices, must be moist (perspiration) and then exposed to sunlight. Giant hogweed is a Federal Noxious weed, making it unlawful to propagate, sell or transport this plant. The NYS Department of Agriculture and Markets should be notified whenever this plant is encountered.
Management Options

1. Digging
Digging out the top 5-6 inches of root mass satisfactorily kills the plant. Recommended for small populations less than ½ acre.

2. Cutting
Mowing, cutting or weed whacking are NOT recommended as control options because the large perennial root system will soon re-sprout as well as increasing potential exposure to the plant sap. The exception to the recommendation is to hand-cut mature seed heads, placed in black plastic bags and disposed of at a licensed landfill. “Cut n Hold” pruners and similar equipment work well in minimizing contact between workers and plant parts while bagging.

3. Herbicide
Recommend foliar spray application by certified applicator with glyphosate (Rodeo) or triclopyr (Vegetation Manager), in accordance with all label instructions, federal, state and local laws. To minimize risk of exposure to the plant’s sap, cutting the plant prior to herbicide application is not recommended.

IV. Detailed Control Practices for Additional Invasive Plant Species

The following are recommended controls for selected specific plants which, though not currently NYSDOT “Priority” species, are representative of the broad plant categories of, respectively, vines, annuals and trees:

**ORIENTAL (ASIATIC) BITTERSWEET, Celastrus orbiculatus (VINE)**

Plant Description:
Oriental bittersweet is a deciduous perennial that invades forests, forest edges, disturbed areas and shorelines. This vine has round alternate leaves and a woody stem. The red fruit (yellow when sheathed with covering) produced by a female plant ripens in September. The berries are found throughout the length of a branch. This differs from the native American bittersweet (C. scandens), which produces berries at the end of branches. A fact sheet identifying the differences between the two species may be found at:

In addition to seed dispersal, bittersweet spreads by root suckering. Bittersweet may climb nearby trees and shrubs up to 60 feet high, covering their canopies, blocking sunlight beneath which ultimately smothers the trees and shrubs to death. Additionally, bittersweet has the ability to girdle what it climbs, usually resulting in mortality of its physical support. The vine can create hazardous tree conditions due to the weight of the vine overwhelming its support, especially in windy conditions and/or when laden with frozen precipitation.

Management Options

1. Pulling
Effectiveness: Good option for small areas < 0.25ac. Labor-intensive.
Method: Seedlings and smaller plants may be hand-pulled, removing as much root as possible. Roots remaining in soil will likely resprout.
2. Cutting
Effectiveness: Cutting and mowing alone requires continuous maintenance during each growing season, year after year. Integrating herbicide methods to cutting offer better results.
Method: Using a two-person team, cut stems as low to the ground as possible and immediately sponge or brush undiluted triclopyr product to the stump. Perform treatment prior to seed development, if possible. If there is concern with impacts to non-target species, stump treatment may be applied later in the fall (>50°F or so) when native species are dormant. As unsightly as it may appear, it is recommended not to attempt removing dead vines from trees and shrubs due to the risk of injuring non-target vegetation.

3. Herbicide
Effectiveness: Foliar and stump treatments are very effective. Foliar application is less labor intensive than stump treatment, but increases the risk of impacting non-target species.
Method: For larger areas of dense cover, use glyphosate or triclopyr products prior to seed development. See stump treatment method under “2. Cutting”.

MILE-A-MINUTE VINE, Polygonum perfoliatum (ANNUAL)

Plant Description:
Mile-a-minute (a.k.a. Devil’s tearthumb) is an herbaceous, annual vine that invades disturbed areas. The stems are reddish with hooks and circular leafy structures called ocreae. The alternate leaves are triangular, light green, and barbed on the undersurface. Small, white, inconspicuous flowers arise from the ocreae. Fruits are metallic blue and segmented with each segment containing a single black or reddish black seed. Mile-a-minute prefers sun, invading open disturbed areas such as fields, forest edges, roadsides, ditches, and stream banks. Its ability to grow up to 6 cm per day allows it to cover existing vegetation quickly. Coverage reduces light beneath infestation, potentially killing the other plants, as well as restricting the establishment of new vegetation. In addition to management options below, biocontrol is being studied as well. Although not yet approved for use in the State, the biocontrol option may provide control for large infestations in the future.

Management Options
1. Pulling
Plant is easily removed by pulling. Caution: due to its barbed stem, use of gloves is highly recommended for plant removal.

2. Mowing
Effectiveness: Repeated mowing during the growing season will prevent the plant from flowering and produce seed. Mowing must be performed over several seasons to exhaust seed bank.

3. Herbicide
Effectiveness: For larger areas of dense cover, apply foliar glyphosate product prior to seed development.
TREE-OF-HEAVEN, *Ailanthus altissima* (TREE)

**Plant Description:**
Ailanthus is a fast-growing deciduous tree that excessively spreads via seed and aggressive rhizomes. Tree has smooth light grey bark with compound leaves that are similar in appearance to sumacs and black walnut. Ailanthus grows well in poor soils, rocky areas, roadsides, forest openings and any other soil condition or habitat imaginable, except in wetlands and shady areas. Roots release toxic (allelopathic) compounds into the soil to reduce establishment of competing plants species.

**Management Options**

1. **Pulling**
   Effectiveness: Due to the robust root mass, any root fragment remaining in ground will likely resprout if larger specimens are pulled. Method may be effective in small, recently-established stands.
   Method: Seedlings and small trees may be pulled, removing all roots.

2. **Cutting**
   Effectiveness: Repeated cutting is required for control and will not eradicate stand. Integrating technique with herbicide treatment increases success of control/ eradication.
   Method: Mowing/cutting best implemented in August, when most biomass is above ground and prior to seed development.

3. **Herbicide**
   Effectiveness: Very effective. Foliar application is less labor-intensive than stump treatment but is less target-specific.
   Methods: Both treatments should be performed in late summer (late August) for best results. Imazapyr (Stalker) may be used for foliar applications.

**Basal Bark Method:** This method is effective throughout the year as long as the ground is not frozen. Apply a mixture of 25% triclopyr and 75% horticultural oil to the basal parts of the tree to a height of 30-38 cm (12-15 in) from the ground. Thorough wetting is necessary for good control; spray until run-off is noticeable at the ground line.

**Hack and Squirt Method:** Using a hand axe, make cuts at 6.5 cm (3 in) intervals around the trunk of the tree, between 15-45 cm (6-18 in) above the ground. Be sure that each cut goes well into or below the cambium layer. Immediately treat the cut with a 50% glyphosate or triclopyr herbicide solution. Do not girdle the tree.